

## A new subfamily of Arionidae (Mollusca, Pulmonata)

by

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### ABSTRACT

A new subfamily, Ariopeltinae, of the pulmonate family Arionidae, containing two new genera (*Ariopelta* and *Ariostralis*) from South Africa, is described. The problematic species *Limax* (*Limas*) *capensis* Krauss, 1848 is referred to *Ariopelta* and a neotype designated. *Limax kraussianus* Heynemann, 1862 (a *nomen dubium*) is regarded as belonging to the Arionidae genus *Ariostralis* rather than to the Urocyclidae. The status of *Amalia ponsonbyi* Collinge, 1900 and *Arion aterrima* Gray, 1855 is discussed.

### INTRODUCTION

The pulmonate family Arionidae has its main area of distribution in western North America, Asia, Europe and northern Africa. It is currently known to be represented in the southern parts of South Africa only by the endemic genus *Oopelta* and two introduced species of the genus *Arion* (Van Bruggen 1964). As the area of distribution of *Oopelta* is so widely separated from the Holarctic region its affinities are problematic (Van Regteren Altena 1966). Simroth (1910) even proposed that *Oopelta* should be given family rank. The discovery of two additional genera of the family Arionidae in South Africa, permits a better evaluation of the family and of the affinities of the genus *Oopelta*. Significantly both genera occur in a region characterised by a number of palaeogenic invertebrates which are mostly relict primitive types (Stuckenberg 1962), and their characteristics suggest that they also should be regarded as relicts. The fact that they are considered to represent a new subfamily of Arionidae further adds to their significance in the interpretation of the phylogeny and systematics of the family. A more detailed account of the anatomy of the two species and a discussion of their significance in the interpretation of the phylogeny and systematics of the family Arionidae is given in a Ph.D. thesis (Sirgel 1984). One of the two species is believed to be the insufficiently described *Limax* (*Limas*) *capensis* Krauss, 1848, for which I propose the new genus, *Ariopelta*.

The two species described in this paper were found near the top end of a narrow ravine, Landdroskloof, situated on the western slopes of the Hottentots Holland Mountains 34°02'S : 18°59'E, within the Hottentots Holland Nature Reserve, about 60 km east of Cape Town and 1 350 m above sea-level. This lies in the so-called mist belt which occupies the upper parts of these mountains. As the habitat varies considerably in mountainous regions it can be expected that stenotopic species may be found in specific limited microhabitats. The area in which these two species were found is limited to a few hundred square metres on the southward facing slope of the ravine. A high cliff on the northern side shades off the sun for the major part of

each day. This, as well as the fact that the locality is covered by mist, normally accompanied by rain or drizzle, for at least a few hours of most days of the year (Table 1), ensures damp and cool conditions. According to Pilsbry (1948) members of the family Arionidae require such conditions. The Jonkersnek rain gauge, which is approximately 5 km away from this site, is known to have recorded a 15-year (1945–1960) mean annual rainfall of 3 539,2 mm. This is the highest measured precipitation in South Africa.

The vegetation in the area consists of a dense growth of Cyperaceae (eg. *Tetraria cuspidata*) and Restionaceae (eg. *Restio perlexum* and *Elegia thyrsifera*). Fungi and a species of moss belonging to the genus *Lophocolea* were found to constitute a considerable part of the contents of the alimentary canal of both species.

#### ABBREVIATIONS

- BM = British Museum (Natural History), London.  
 MACT = Musée de l'Afrique Centrale, Tervuren, Belgium.  
 NM = Natal Museum, Pietermaritzburg, South Africa.  
 RMNH = Rijksmuseum van Natuurlijke Historie, Leiden.  
 SAM = South African Museum, Cape Town.  
 SMNS = Staatliches Museum für Naturkunde, Stuttgart.

TABLE 1

Climatic conditions prevailing at the type locality of *Ariopelta capensis* (Krauss) gen. n. and *Ariostalis nebulosa* gen. n., sp. n. Average days per month (1980–1983) during which A = locality was covered with a mist or experiencing rain throughout the entire day; B = locality experienced mist and/or rain for at least 6 hours of the day; C = locality was clear throughout the entire day. Dew and conditions overnight not taken into consideration.

Month	Various climatic conditions at locality (average days per month)		
	A	B	C
Jan.....	17	8	6
Feb.....	14	6	8
March.....	15	7	9
April.....	16	5	9
May.....	18	4	9
June.....	18	4	8
July.....	17	3	11
Aug.....	20	6	5
Sept.....	18	3	9
Oct.....	17	5	9
Nov.....	16	6	8
Dec.....	19	5	7
Total.....	205	62	98

## SYSTEMATICS

## Family: Arionidae

Subfamily: **Ariopeltinae** subfam. n.

Diagnosis: Jaw oxygnathous. Radula basically corresponds to arionid type (Fig. 1), central tooth tricuspid with mesocone much longer than ectocones, laterals and marginals bicuspid with mesocone long and ectocone much smaller. Granular mantle on which a groove, extending in the shape of a horseshoe, is occasionally discernable in living animals. Pneumostome situated halfway between front and rear ends of mantle and across slit extending from edge of mantle. Shell strong, completely covered by mantle, oval and dorsally convex with nucleus at posterior end, surface covered by growth lines and posterior edge curled ventrally to form a

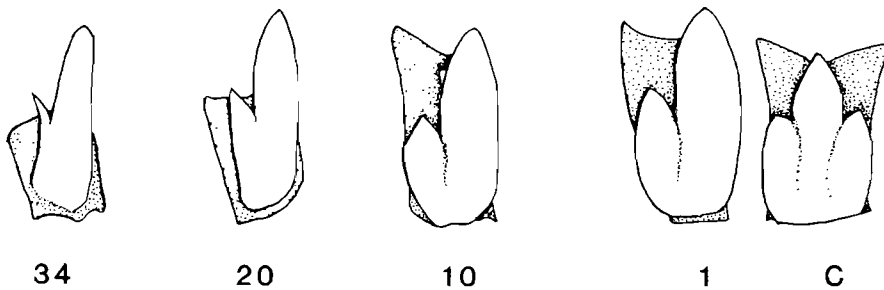


Fig. 1 *Ariopelta capensis* (Krauss) gen. n. Teeth from the radula. C = central; numbers indicate position of tooth in relation to the central tooth.

small ledge at posterior end of concave ventral side. Sole of foot not divided by longitudinal grooves. Retractor muscles of pharynx and tentacles long, with common origin at posterior margin of diaphragm. No retensor muscle. Both vagina and free oviduct distinctly longer than genital atrium. Proximal end of vagina enlarged to form a vaginal bulb joined by spermathecal duct (Fig. 6). Calcareous or cartilaginous structures projecting into lumen of vaginal bulb and attached to its wall. Penis consisting of four successive regions (Figs 6 & 8); a slender, short, proximal region entered by vas deferens and onto which penis retractor inserts, containing a penis papilla in its lumen; second and third parts larger with calcareous spines projecting into lumen; fourth part long and slender. Genital aperture ventral to base of upper tentacle on right side.

The two genera described below are assigned to the family Arionidae on the basis of the structure and arrangement of the pallial organs; the basic structure of the radula; the arrangement of the alimentary tract into two posteriorly directed loops; the fact that the mantle slit extends centrally through the pneumostome and the shell representing a reduced condition. Neither the possession of an oxygnathous jaw nor the presence of calcareous spines in the penis disqualify these two genera from the family Arionidae, as an oxygnathous jaw is present in the genus *Oopelta* and the genus *Anadenus* has calcareous spines in the penis.

Some of the characters of the two new genera agree with those of the subfamily Anadeninae (large penis with spines); others agree with Oopeltinae (oxygnathous jaw, distribution) and some even show resemblance to some of the North American subfamilies (arrangement of retractor muscles, strong internal shell). The combination of their characters, however, exclude them from any of the existing subfamilies.

**Ariopelta gen. n.**

Diagnosis: Caudal end of body acuminate (Fig. 2). No caudal pore. Foot fringe very narrow. Calcareous structure, borne on wall of vaginal bulb, projects into the lumen. Calcareous spines of penis, not dominated by one giant spine.

Type species: *Limax (Limas) capensis* Krauss, 1848 by present designation.



Fig. 2 *Ariopelta capensis* (Krauss) gen. n. Note acuminate rear end. Scale = 10 mm.

***Ariopelta capensis* (Krauss, 1848)**

*Limax (Limas) capensis* Krauss, 1848: 73

*Amalia capensis*; Heynemann, 1862: 215

*Milax capensis*; Connolly, 1939: 181

Description: Average length contracted 25 mm, stretched 140 mm. Colour black. Body posterior to mantle usually giving impression of being keeled (This 'keel' can at times be smoothed out or even transformed into a narrow groove with the result that the body then appears rounded dorsally). Tubercles on body surface elongate. Mucus clear and watery. Sole of foot narrower than body, can be transformed into a very narrow-grooved structure when irritated (the result is that the body then becomes laterally compressed to such an extent that the animal cannot remain upright and falls over onto one side). Shell completely covered by granular mantle. Cerebral commissure about as long as lateral connectives, cerebral ganglia thus located dorso-laterally in circumpharyngeal nerve ring (Fig. 4). Retractor muscles of tentacles diverge from a common trunk. Pharyngeal retractor diverges from left tentacle retractor and branches into two near buccal mass. Origin of penis retractor muscle practically contiguous with common origin of tentacle retractors (Fig. 5). Ootestis unpigmented, acini small, lobed and tightly packed. Spermathecal duct short. Vagina long (Fig. 6). Short genital atrium surrounded by a thick muscular



Fig. 3. *Ariopelta capensis* (Krauss) gen. n. shell. A = Dorsal view, B = Ventral view. Scale = 1 mm.

wall forming a conical structure which includes part of vas deferens. Radular formula 49:C:49  $\times$  109. Except for bases of upper tentacles no pigmentation of internal organs. Calcareous shell as an oval, vaulted plate (Fig. 3) 9  $\times$  5 mm; nucleus located at posterior end 3  $\times$  2.5 mm, apparently smooth. Posterior edge of shell curled ventrally and slightly anteriorly to form a small ledge on ventral side. Dorsal surface, with irregular growth lines, covered by a thin almost clear, corneous periostracum. Posteriorly edge of shell, on right side, follows a more or less straight line extending at an angle of about 45° to longitudinal axis. More or less opposite centre of nucleus this straight line stops as margin of shell describes an obtuse angle and then follows an oval course with result that shell appears slightly expanded on right side near posterior end (Fig. 3). As no such expansion occurs on left side, growth lines seem to originate opposite to posterior end of nucleus on right side but to end more anteriorly, more or less opposite centre of the nucleus on the left (Fig. 3). Uneven outline of shell gives illusion that nucleus of shell, instead of being located on median line, is slightly displaced towards the left. In some specimens periostracum extends slightly past calcareous edges of shell. Ventral surface of shell concave with deepest part of concavity at nucleus. In some specimens a thick calcareous deposit fills concavity resulting in shell being a thick structure with an almost flat ventral surface (Fig. 3).

Material examined: As the unique holotype, originally housed in the Staatliches Museum für Naturkunde, is now lost (Dr Janus pers. comm.) a neotype is here designated. Neotype and 4 other specimens, SOUTH AFRICA, *Cape Province*, Hottentots Holland Nature Reserve, Landdroskloof, 34°03'S:18°59'E, altitude

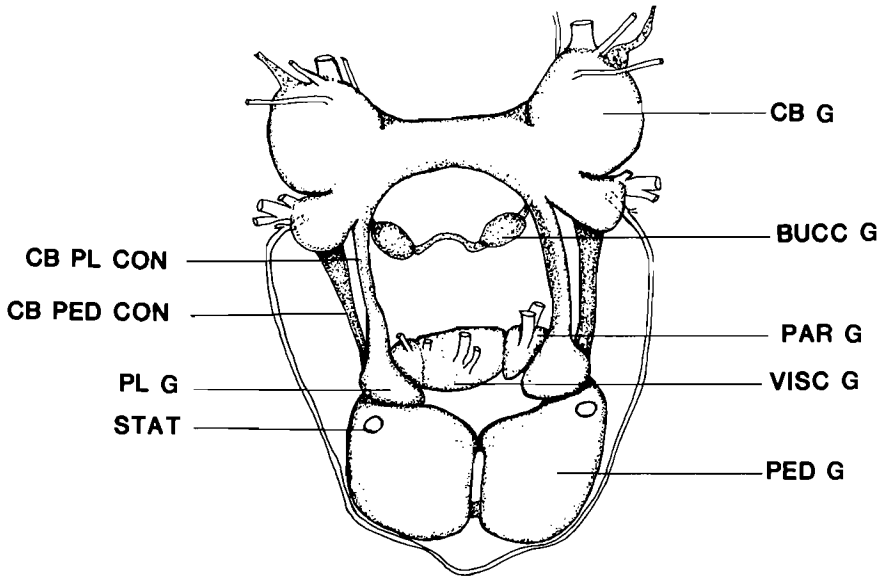


Fig. 4 *Ariopelta capensis* (Krauss) gen. n. Central nervous system. BUCC G = Buccal ganglion, CB G = Cerebral ganglion, CB PED CON = Cerebropedal connective, CB PL CON = Cerebro-pleural connective. PAR G = parietal ganglion, PED G = Pedal ganglion, PL G = Pleural ganglion, STAT = Statocyst, VISC G = Visceral ganglion.

1 350 m, 29 September 1977, W. F. Sirgel (Natal Museum, B6036/T2742); 11 specimens, same locality data, 12 April 1977 (2), 19 April 1983 (2), 23 April 1983 (7), W. F. Sirgel. All the material is preserved in 70 % alcohol and has been deposited in the following institutes: BM (2), MACT (2), NM (4), RMNH (3), SAM (2), SMNS (2).

Discussion: In 1848, Krauss described *Limax* (*Limas*) *capensis* from South Africa. Later Collinge (1900) described another species from Cape Town (*Amalia*

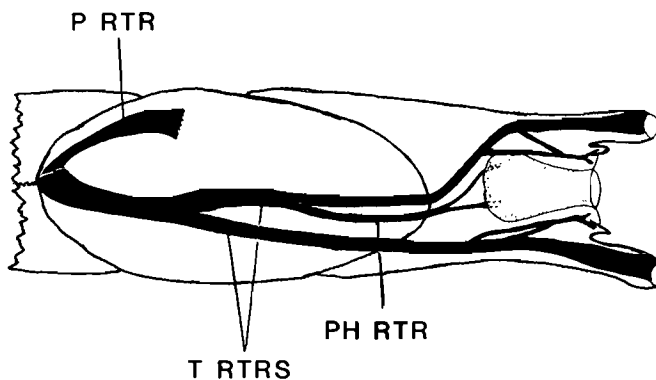


Fig. 5 *Ariopelta capensis* (Krauss) gen. n. Arrangement of the retractor muscles of the pharynx and tentacles. PH RTR = Pharyngeal retractor, P RTR = Penis retractor, T RTRS = Tentacle retractors.

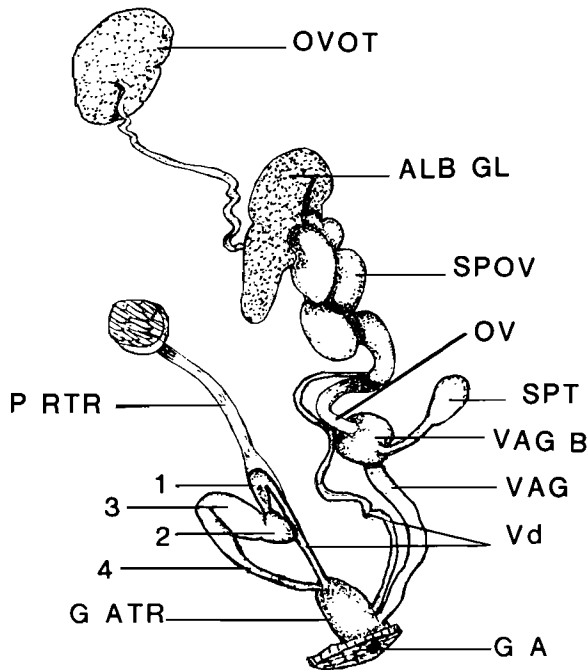


Fig. 6 *Ariopelta capensis* (Krauss) gen. n. Genital System. ALB GL = Albumen gland, G A = Genital aperture, G ATR = Genital atrium. OV = Free oviduct, OVOT = Ovotestis, P RTR = Penis retractor muscle, SPOV = Spermoviduct, SPT = Spermatheca, VAG = Vagina, VAG B = Vaginal bulb, Vd = Vas deferens. 1-4 indicate the successive parts of the penis.

*ponsonbyi*). Both these taxa have caused taxonomic problems as the types have been lost and no material has been collected. Inclusion of these species in the genera *Limax* and *Amalia* (= *Milax*) has to be questioned as the family Limacidae is not considered indigenous to South Africa. A third problem species is *Arion aterrima* Gray, 1855. These three taxa are discussed below.

#### *Limax (Limas) capensis* Krauss, 1848

*Limax (Limas) capensis* Krauss, 1848 was described from a preserved and faded specimen as 27 lines long (= 61 mm). According to Connolly (1939), who also had only Krauss' measurements, the specimen was 69 mm long. The width of the body according to Krauss was '4.5 lin.' (about 10 mm). Connolly's conversion agrees with this latter measurement. According to Krauss the body was smooth, elongate, slender, subcylindriform, apparently keeled, acuminate at the posterior end; mantle elongate-oval, 22.5 mm long, thin and rounded at each end. He adds that posteriorly it contained a solid, roundish shell which was smooth and convex, with irregular, concentric and indistinct radial striae above, but rough beneath; the apex was indistinct and situated on the anterior margin. Krauss further mentioned that the respiratory orifice lay somewhat behind the middle of the mantle and merely gave the locality of this slug as 'in provincia capensi'.

Benson (1851) mentions a keeled slug found under stones at Newlands and Rondebosch, now built-up suburbs of Cape Town situated on the eastern side of the Table Mountain range. Heynemann (1862) regarded this slug as *Limax* (*Limas*) *capensis* Krauss, 1848. If correct, this would indicate a more exact locality for Krauss' species. Information on the slug mentioned by Benson (1851) is, however, so meagre that it is quite possible that he had the introduced *Milax gagates* (Drapernaud, 1801), which could have already been present at the Cape, although not officially recorded at that time. Alternately it might have been *Amalia ponsonbyi* Collinge, 1900.

When Heynemann (1962) examined the type specimen of *Limax capensis*, he found that only the shell remained. On the strength of Krauss' reference to a keel and the resemblance of the shell to that of *Amalia marginatus*, he transferred this slug to the genus *Amalia*. He described the shell as solid, not membranous at the margin, oval with a tendency to quadrangulation and with the nucleus on the central line. The obtuse angle formed by the edge of the shell of *Ariopelta capensis* also gives the impression that it has a tendency to quadrangulation. This feature is especially pronounced in the shell of younger individuals and is an indication of the spiral shape of the ancestral shell. Heynemann also mentions that H. & A. Adams (1855) referred to *Limax capensis* as '*Limax krausii* (= *campestris*)', but rejects this in the absence of explanatory data.

Connolly (1939) gave three figures of the holotype shell, which then measured '4.5 × 3.0 mm', and mentioned that it was covered by a calcareous deposit and had 'obviously undergone considerable change' since the time of its original description. Krauss (1848) gave the dimensions as '2.6 lin. long., 2.2 lin. lat.' (approximately 6.0 × 5.1 mm). Connolly referred *capensis* to *Milax* regarding *Amalia* as a synonym.

Smith (1884), *fide* Connolly (1916), considered that Krauss had founded his *Limax capensis* on *Milax gagates*. Although the date of the introduction of the latter into South Africa is not known, Connolly (1916) mentioned that it was collected here by the Challenger expedition in 1873. Cockerell (1890) disputed that *Amalia capensis* was a synonym of *Amalia gagates*, so far as he could judge from its description. Serious doubts about the validity of *capensis*, however, remained. Thus van Regteren Altena (1966) still considered *Limax capensis* Krauss a likely synonym of *Milax gagates*, supporting this with the statement that no additional evidence of endemic species of *Milax* occurring in South Africa has been advanced since the descriptions of *M. capensis* and *M. ponsonbyi*.

The species that I here call *Ariopelta capensis* corresponds well with published data on *Limax capensis*. Although Krauss described his preserved specimen as smooth, and my living material is covered with tubercles, the body of the latter also takes on a smooth appearance when fixed. The descriptions of the shell of *Limax capensis* as given by Krauss (1848), Heynemann (1862) and Connolly (1939) agree with the structure and dimensions of the shell in my material. The only potentially significant difference is that, according to Krauss, the apex of his shell was on the anterior margin while in mine it is near the posterior margin. He is, however, clearly in error as the shell plate in pulmonate slugs is normally orientated in such a way that the apex (= nucleus) is situated posteriorly.



Although *Limax* (= *Ariopelta*) *capensis* is here shown to be a valid species, early attempts to synonymise it with *Milax gagates* are understandable as the two show considerable external resemblance to one another. The most obvious differences are that *A. capensis* is more shiny and intensely black, the keel is less prominent and the slit from the mantle edge passes right through the centre of the pneumostome instead of through its anterior edge as in *M. gagates*. Specimens of *M. gagates* examined by me further differ from *A. capensis* in the groove on the mantle being angulate at its median point instead of having an evenly horseshoe-shaped course. Krauss does not mention this groove in his description of *Limax capensis*, but it should be noted that, while the groove normally remains distinct in preserved specimens of *M. gagates*, it often becomes indistinct in preserved specimens of *A. capensis*. The sole of the foot of *M. gagates* is clearly divided into three tracts by two distinct longitudinal grooves while that of *A. capensis* is undivided.

*Amalia ponsonbyi* Collinge, 1900

Another new species of slug, collected by Lightfoot at a locality given as Cape Town, was described as *Amalia ponsonbyi* by Collinge in 1900. Connolly (1939) cited it as *Milax ponsonbyi* and mentioned that the type was in the collection of the Cambridge Museum. According to Collinge's description the species has the following characteristics: 'Dorsally sepia blue, gradually becoming yellowish laterally and towards the foot fringe; mantle same as dorsum, groove on mantle well marked. Keel well developed. Rugae small. Sulci faint sepia coloured. Peripodial groove narrow but distinct. Foot-fringe dirty yellow. Footsole yellowish, divided into median and lateral planes, . . . Length (in alcohol) 32 mm. Shell a smooth, nearly ovoid calcareous nodule, slightly broader posteriorly than anteriorly; major diam. 5, min. diam. 3.2 mm.' Such a shell would resemble that of young individuals of *A. capensis*. Collinge significantly remarked that 'Externally this species is not unlike some forms of *Amalia gagates*' (= *Milax gagates*) but that 'the general form of the generative organs, however, at once separates it from that species'.

According to Collinge's description and figure of the genital system, the genital atrium is single and small. The vagina is short, spermatheca large and globular with a short spermathecal duct. He simply described the penis and vas deferens as 'the sperm-duct', without differentiating between them, but mentioned that the external form of this part is very characteristic. The unfortunate omission of the retractor muscle of the penis from his figure makes it difficult to interpret this part of the genital system. He figures the sperm-duct, distally to the vas deferens, as a prominent structure with a constriction in its middle. More distally this structure is figured to be followed by a slender tube which again connects to a relatively small but wider structure consisting of a proximal dilation followed by a slightly larger distal dilation which opens into the genital atrium. According to the figure a small atrial gland is attached to the genital atrium. Collinge, however, did not mention this gland in his description.

Although differing in detail, the male genital duct in *Amalia ponsonbyi* (described as located distally to the slender part of the vas deferens) conforms to

the basic pattern of the penis in *Ariopelta capensis*. Furthermore the two taxa seem to resemble each other externally in the apparent presence of a keel, well-marked groove on the mantle, small rugae, narrow peripodial fringe and the general shape of the body. No significant differences can be deduced from the descriptions of the shells. The tripartite appearance described for the sole of *Amalia ponsonbyi* is probably an artifact caused by the preservation of the specimen. This is occasionally found in preserved specimens of *Ariopelta capensis* as well.

According to Collinge's (1900) figure the spermatheca appears larger and its duct shorter than that normally found in *A. capensis*. This difference, however, may result from the spermatheca having been in a maximal distended state when the specimen was fixed. Significantly the spermathecal duct is relatively short as in *A. capensis* as well as in some *Oopelta* species. The apparent colour difference between *A. capensis* and *M. ponsonbyi* is deceptive as Collinge based his description on preserved material. A potentially significant difference between the two species is the occurrence of an atrial gland as depicted by Collinge in his figure of the genitalia of *Amalia ponsonbyi*. The presence of this structure probably influenced Collinge in his choice of a genus as an atrial gland is characteristic of *Amalia* (= *Milax*) species. Although such a gland does not occur in *Ariopelta capensis*, in one case where the genital system was removed from the animal, a structure resembling the atrial gland described for *Amalia ponsonbyi*, in both shape and position, was seen. Careful observation and comparison with other specimens, however, made it clear that this was part of the tissue surrounding the atrium and connecting it to the body wall, which partly tore away during the dissection. It is very likely that Collinge could have based his atrial gland on such an artifact, especially if it is borne in mind that he only had one specimen.

Another apparent difference from *A. capensis* is that according to Collinge's figure, *Amalia ponsonbyi* does not possess the globular dilation of the female tract where the duct of the spermatheca opens into it. This may be of less significance than appears at first sight. One specimen of *Ariopelta capensis* collected during May 1977 (ie. winter), instead of the globular dilation of the tract, only exhibited a slight oval widening largely located proximally to the connecting point of the spermathecal duct. This widening could have gone unnoticed if its significance was not known. In this connection, it should be noticed that, according to Collinge's figure, the corresponding part of the genital system of *A. ponsonbyi* is drawn relatively wide.

The short vagina of *A. ponsonbyi* indicates a clear difference from *Ariopelta capensis*, where a relatively long vagina occurs. A further difference is that the penis in *A. capensis*, in situ, is typically folded in two places so that it more or less takes on the shape of the letter 'Z'. Collinge's figure shows the penis of *M. ponsonbyi* to be folded only once and less sharply. Although it is unlikely with fixed material, it must be borne in mind that Collinge, prior to drawing the penis, could have stretched and pinned it out in such a way that his drawing does not reflect its normal profile.

From the available information there is good reason to suspect that *Amalia ponsonbyi* should be transferred to the new genus *Ariopelta*. This is in full agreement with van Regteren Altena's (1966) belief that it is unlikely to be an indigenous *Milax*, as no other indigenous Limacidae had been found in this country

since its description. As far as the identity of the species is concerned the short vagina and finer details of the penis seem to differentiate it sufficiently from *Ariopelta capensis* to indicate that it may be a distinct species.

*Arion aterrima* Gray, 1855

Gray (1855) described a slug from South Africa, housed in the collection of the British Museum (Natural History) as *Arion aterrimus*. He reported that it was black; the back had very large, elongate rugosities and the animal was as large as *Arion ater*. Cockerell (1890) reported examining a slug, in the British Museum, labelled '*Limax (Arion) allerian* South Africa', which he believed was Gray's *Arion aterrimus*. In his description of the specimen he mentioned that it was 'smoothish' and not keeled, while it had linear grooves, running from the mantle to the foot, about 2 mm apart. He added that the mantle was granulose, bluntly angled behind and that the pneumostome is anterior of the middle of the mantle. Cockerell (1890, 1891) referred the species to *Oopelta* and Melvill & Ponsonby (1893) followed suit.

The black colour of *O. aterrima* invites comparison with *Ariopelta capensis*. Dr P. B. Mordan in 1980 kindly compared specimens of *A. capensis* with the type of *O. aterrima* in the British Museum (Natural History). He found that *O. aterrima*, as do many other *Oopelta*, differs from *A. capensis* in lacking a keel and shell.

Collinge (1901) stated that the type of *O. aterrima* is 'exactly similar', apart from size, to specimens in the collection of the Zoological Museum of the University of Copenhagen, labelled *Oopelta nigropunctata* Mörch. The latter species which in life has a greyish ground colour, sometimes does turn black when preserved. Although I have not noticed this colour change in other species of *Oopelta* the possibility of it happening cannot be excluded. It is thus feasible that *O. aterrima* is based on another *Oopelta* species which has changed colour in its preservative. According to van Regteren Altena (1966) it is not possible to ascertain whether *O. aterrima* is a synonym of any of the other *Oopelta* species while its internal anatomy is unknown. The absence of a keel and caudal mucus pore (Collinge 1901) as well as the presence of large rugosities (Gray 1855) in *O. aterrima*, exclude the possibility of it being a synonym of *Ariopelta capensis* or *Ariostralis nebulosa*.

***Ariostralis* gen. n.**

Diagnosis: Caudal pore at posterior end of body. Peripodial grooves slope upwards posteriorly to end laterally in caudal pore. Foot fringe thus relatively wide. Vaginal bulb contains cartilaginous but no calcareous structures. Calcareous spines in penis dominated by one giant spine.

Type species: *Ariostralis nebulosa*

***Ariostralis nebulosa* sp. n.**

Description: Average length contracted 15 mm, extended 55 mm. Colour black, dark grey or brownish grey. No keel, body rounded dorsally (Fig. 7). Tubercles on surface of body hexagonal. Mucus clear and sticky. Sole at least as wide as body, cannot be narrowed and forms a wide flat structure when contracted. Shell



Fig. 7 *Ariostralis nebulosa* gen. n., sp. n. Note caudal pore at rear end. Scale = 10 mm.

completely covered by granular mantle. Cerebral commissure distinctly longer than short side connectives, cerebral ganglia consequently located laterally in circumpharyngeal nerve ring (Fig. 8). Although tentacle and pharyngeal retractor muscles have a common origin they do not diverge from a common trunk. Origin of penis retractor muscle well separated from the latter origin and located postero-laterally of margin of mantle (Fig. 9). Ootestis with pigmented surface, consists of large, tubular and loosely packed acini. Spermathecal duct long, curving around base of retractor muscles and extend back as far as albumen gland. Vaginal bulb contains a second, inner, perforated, cartilaginous wall, suspended from outer one by strands of cartilaginous tissue. Genital atrium very short, almost non-existent (Fig. 10). Radular formula 33:C:33  $\times$  120. Pharyngeal bulb has a pigmented area on its dorsal surface.

Calcereous shell 4,0  $\times$  2,2 mm, nucleus 1,0  $\times$  0,8 mm, concave ventral side not filled up by rough calcareous deposit. Except for the absence of this deposit and the smaller size the shell resembles that of *Ariopelta capensis*.

Material examined: Holotype: SOUTH AFRICA, Cape Province, Hottentots Holland Nature Reserve, Landdroskloof, 34°02'S:18°59'E, altitude 1 350 m, 19 April 1979, W. F. Sirgel (Natal Museum, no B6035/T2741). Paratypes: same data

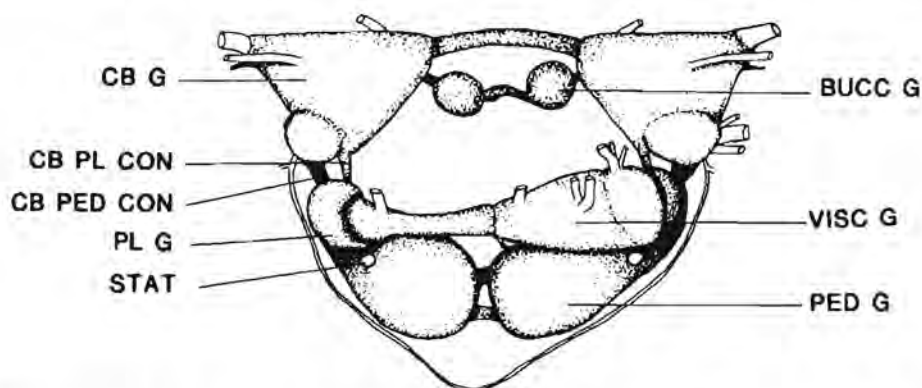


Fig. 8 *Ariostralis nebulosa* gen. n., sp. n. Central nervous system. BUCC G = Buccal ganglion, CB G = Cerebral ganglion, CB PED CON = Cerebro-pedal connective, CB PL CON = Cerebro-pleural connective, PED G = Pedal ganglion, PL G = Pleural ganglion, STAT = Statocyst, VISC G = Visceral ganglion.

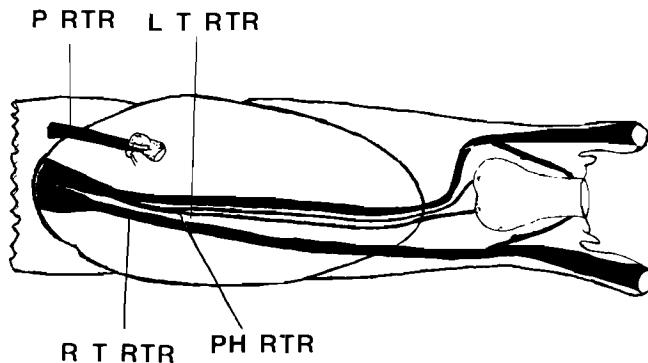


Fig. 9 *Ariostralis nebulosa* gen. n., sp. n. Arrangement of the retractor muscles of the pharynx and tentacles. PH RTR = Pharyngeal retractor, L T RTR = Left tentacle retractor, P RTR = Penis retractor, R T RTR = Right tentacle retractor.

(3); *ibidem*, 21 April 1983, W. F. Sirgel (10). All the above material is preserved in 70 % alcohol and has been deposited in the following institutes: BM (2), MACT (3), NM (3), RMNH (3), SAM (2).

Discussion: Another problematic slug was described by Krauss (1848) as 'Limax (Arion) ---?' *Arion*, the type genus of the family Arionidae is, however, not indigenous to South Africa. Krauss characterised the animal as 'less slender and delicate than *Limax (Limas) capensis*, greyish black, rugose, 1½ inch long (= 37,5 mm); mantle ovate thick; no shell, pneumostome located somewhat in front of the middle of the mantle. Habitat: Garden, Cape Town'.

Heynemann (1862), who examined four syntypes, commented that Krauss probably assigned the mollusc to *Arion* because he could not find a shell, because the mantle in the type material is not distinguishable from that of *Arion* and the pneumostome does not appear to be located in the posterior part of the mantle. Heynemann, however, found a shell in one of the four specimens which he examined more closely than the others and remarked that a shell is sometimes absent in the genus *Limax*. He adds that the concentric grooves on the mantle of *Limax* are not discernable on dead animals and that the anterior parts of the bodies of Krauss' specimens were so shrunken by the alcohol that the pneumostome appeared to lie at the middle of the mantle. This, together with his failure to locate the caudal gland, which is characteristic of *Arion*, as well as the apparent resemblance between the structure of the jaw and radula of this species and that of *Limax*, persuaded Heynemann to propose the name *Limax kraussianus* for it.

Heynemann declared that Krauss' statements about the absence of the shell and the location of the pneumostome were in error. He amended the description as follows; shell thin, convex, broad, membranous on the margin, with easily discernable growth lines; jaw with a short narrow, not prominent projection, forming a ridge which runs over the jaw. He further mentioned that the radular denticulation resembles that of *Limax* (= *Agriolimax*) *agrestis* and adds: middle denticle triangular, broader than that of *agrestis*, with two ectocones; laterals with a

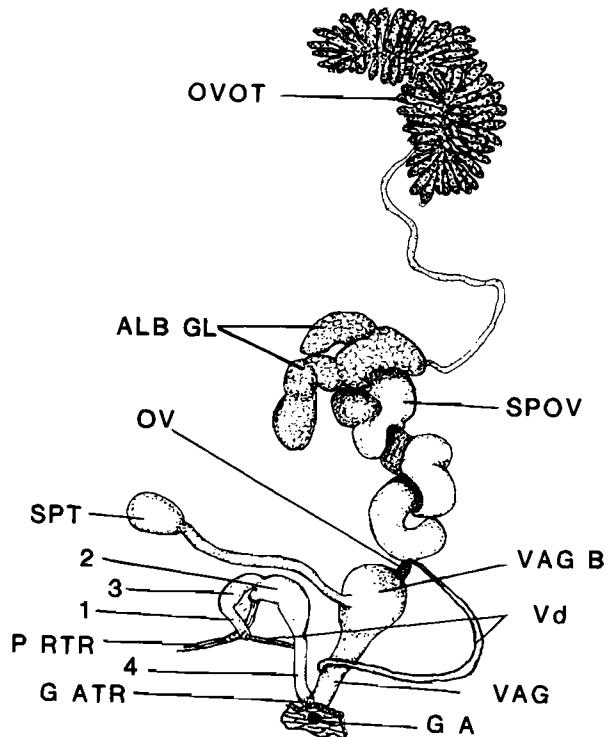


Fig. 10 *Ariostralis nebulosa* gen. n., sp. n. Genital System. ALB GL = Albumen gland, G A = Genital aperture, G ATR = Genital atrium. OV = Free oviduct, OVOT = Ovotestis, P RTR = Penis retractor muscle, SPOV = Spermoviduct, SPT = Spermatheca, VAG = Vagina, VAG B = Vaginal bulb, Vd = Vas deferens, 1-4 indicate the successive parts of the penis.

single ectocone; marginals commence from no. 24, their apices curved like thorns, ectocones still present; at no. 33 the thorn is fully developed but the ectocone has disappeared, in its place a tubercle is present on the lateral base of the thorn, this should according to the analogy be displaced further up the thorn on the denticles nearer to the margin of the radula. He stated that he could not see the lateral margin of the radula.

Heynemann later (1863) stated that the marginal denticles of *Limax kraussianus* differ from those of *Agriolimas agrestis* and its near relatives. His figure on the radula of *Limax kraussianus*, in my opinion, seems to fit the basic pattern of the radula of Arionidae. The reasons given by Heynemann (1862) for the allocation of this slug to *Limax* exclude *Arion* as the possible genus, but do not exclude the family Arionidae, as these characteristics are all found in other genera of this family. *Binneya*, *Hemphillia* and *Ariolimax* for instance all possess a shell (Pilsbry 1948). An internal shell has now also been found in *Ariopelta* and *Ariostralis*. Furthermore the median projection of the jaw (which Heynemann considered to be characteristic of Limacidae) is present in the South African genera of Arionidae

(*Oopelta*, *Ariopelta* and *Ariostralis*). In fact, a ridge crossing the median area of the jaw, similar to the one Heynemann (1862) described for *Limax kraussianus*, is better defined in the latter three genera than in any specimen of several Limacidae species examined by me.

Although Heynemann claimed that the position of the pneumostome had been altered by the preservative, he had only seen the material in the preserved state and his argument was based purely on speculation. Accordingly there is no reason to doubt Krauss' description of the position of the pneumostome (slightly in front of the middle of the mantle).

Subsequently Heynemann (1885), after a re-examination of his syntypes, mentioned that he had now discovered a caudal pore which indicated that they could not belong to the genus *Limax*. It does, however, strengthen the possibility that they could be members of the family Arionidae.

The absence of further records of *Limax kraussianus* from Cape Town, as well as subsequent confusion about the locality (Heynemann 1885, 1906), has led to serious doubts as to whether such a species has ever been found at the Cape. The discovery of *Ariostralis nebulosa* at a locality not more than 60 km from Cape Town, however, renders it possible that such an endemic slug could have been found in the vicinity. In fact the descriptions given for it by Krauss (1848) and Heynemann (1862, 1863, 1885) also apply to *Ariostralis nebulosa*, which could prove to be a synonym.

In my opinion *Limax kraussianus* is a *nomen dubium* because of the controversial descriptions of Krauss (1848) and Heynemann (1862, 1863, 1885) which, being based mainly on external features, are not sufficient for positive identification, particularly as they do not even agree in their interpretations (Heynemann 1862). Furthermore the type material seems to have deteriorated (Connolly 1939). Finally, confusion as to the type locality was introduced by Heynemann (1885, 1906).

Heynemann (1885: 293) mentioned that Krauss (1848) described a slug from the Cape as '*Limax (Arion) spec?*'. In reality Krauss gave the locality more precisely as 'In den Gärten der Kapstadt' (p. 73) and not merely as the 'Cape' which in those days could just as well refer to the whole of southern Africa. On the next page Heynemann (1885) mentioned that this slug possibly could have been regarded to belong to the genus *Arion* but that he, since the discovery of African limaciform pulmonates with open and closed aperture of the mantle (he evidently here referred to the opening on the mantle leading to the shell sac in Urocyclidae) and possessing a caudal pore, had realised that he had erred seriously by referring to this slug as *Limax kraussianus*. During a re-examination of the material he discovered the caudal pore and consequently referred to it as '*Urocyclus? Kraussianus* Heynem., Natal'. No reference is made to Cape Town as a locality, neither is there any explanation for Natal as a locality.

The radula which Heynemann (1863) figured for *Limax kraussianus* conforms to the basic arionid pattern. It does differ from the pattern described and figured by van Mol (1970) and van Goethem (1977) for the radula of Urocyclidae to which family Heynemann (1885) assigns this slug. Heynemann himself, however, clearly demonstrated a lack of confidence in his choice of *Urocyclus* as the appropriate genus by adding a question mark to the generic name.

Collinge (1910) in his paper on the slugs of Natal remarked that, although he had examined large numbers of specimens of this genus, nothing similar to *Urocyclus kraussianus* had passed through his hands. Cockerell (1891) only mentioned *U. kraussianus* as a species from the Cape region. Heynemann (1906) admitted that its allocation to a genus seemed problematic and mentioned that Cockerell was of the opinion that it could not belong to the genus *Urocyclus* while its locality was given as the Cape. According to Dr A. C. van Bruggen (pers. comm.) the genus *Urocyclus* has never been found south of Durban (Natal). Heynemann (1906) reacted to Cockerell's (1891) statement by declaring that, according to his knowledge, he never mentioned the Cape but always Natal, as the locality for *Urocyclus kraussianus*. Heynemann (1906) was, however, incorrect as he previously (1862) clearly stated that he examined the material which Krauss (1848) described as '*Limax (Arion) spec?*' from Cape Town and that he based the name '*Limax Kraussianus*' on this material. He changed the latter name to *Urocyclus kraussianus* in 1885 after a re-examination of the material. The possibility that Heynemann (1862, 1885) could have had different species in mind, when referring to '*Limax Kraussianus*' from Cape Town and *Urocyclus kraussianus* from Natal, seems therefore to be improbable. Simroth (1898) and Connolly (1939) by implication agree with this point of view by giving both Cape and Natal as localities for *Urocyclus kraussianus*. From Collinge's (1910) work it is clear that he also believed that Heynemann referred to the same species firstly (1862) as *Limax kraussianus* and afterwards (1885) as *Urocyclus kraussianus*.

From the above arguments it seems very probable that the slug initially described as '*Limax (Arion) ---?*' by Krauss, was indeed found in Cape Town and belongs to my new genus *Ariostralis*. Although possibly identical to *A. nebulosa* it remains a *nomen dubium* due to the loss (by deterioration) of the type material and the inadequacy of the published descriptions.

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